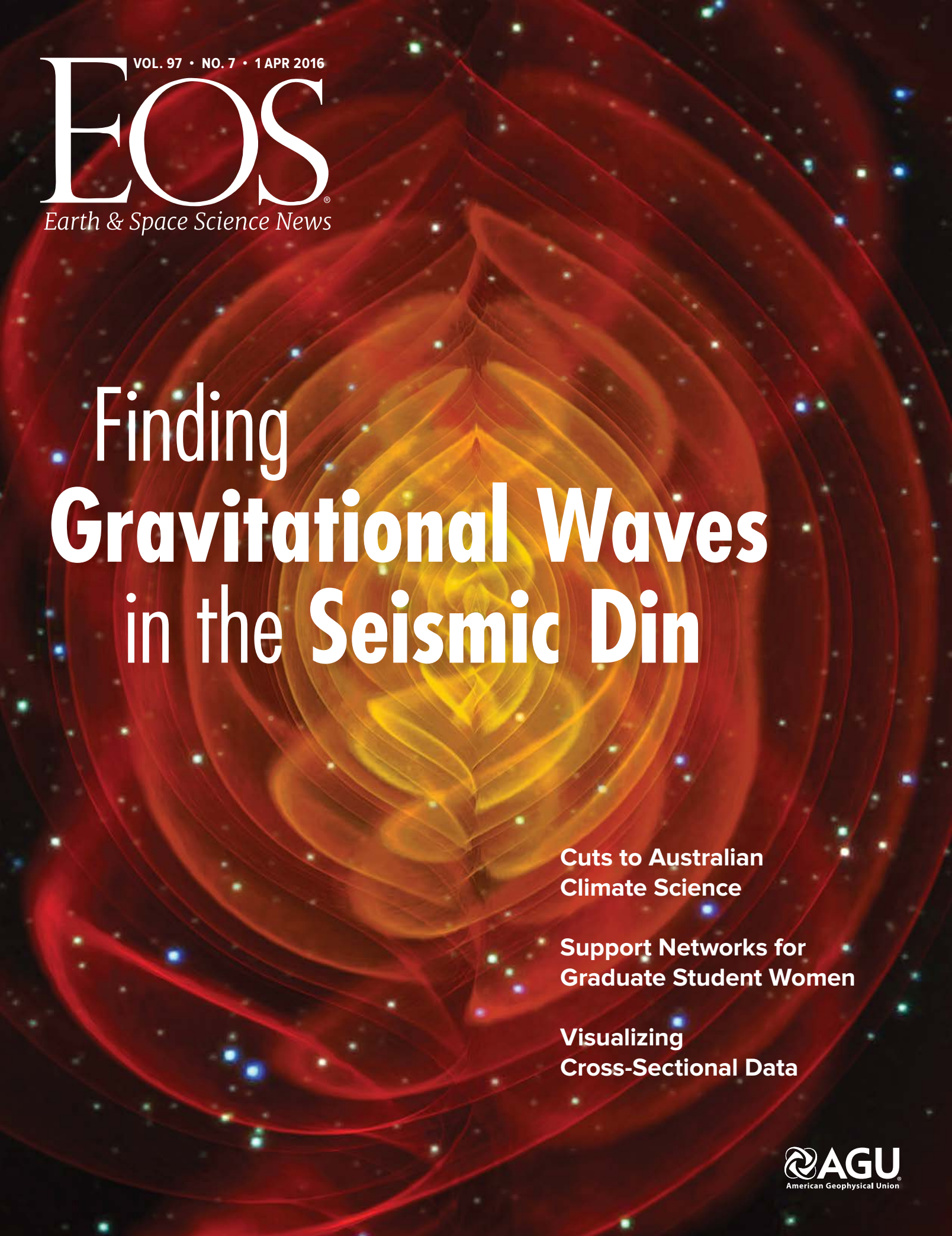
VOL. 97 • NO. 7 • 1 APR 2016

EOS

Earth & Space Science News

Finding Gravitational Waves in the Seismic Din



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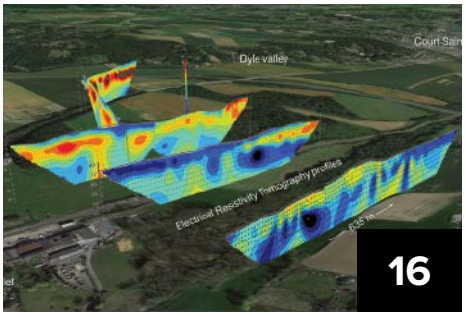

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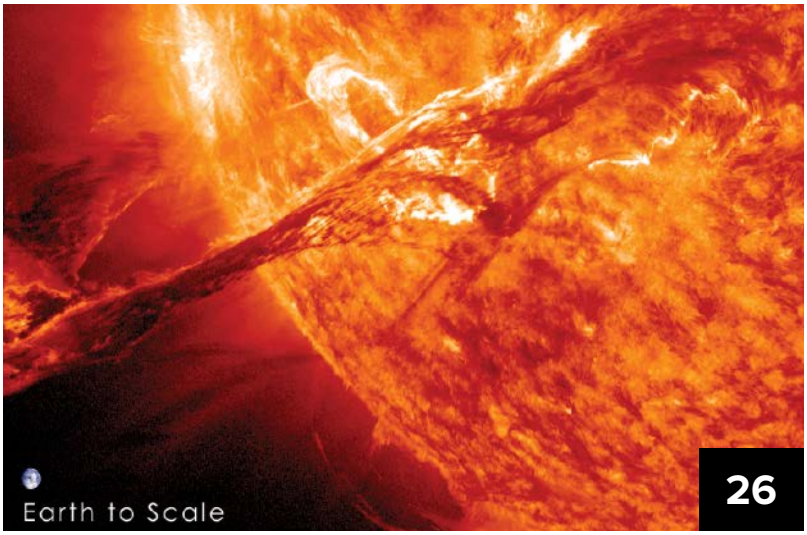

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Eos (ISSN 0096-3941) is published semi-monthly, on the 1st and 15th of the month by the American Geophysical Union, 2000 Florida Ave., NW, Washington, DC 20009, USA. Periodical Class postage paid at Washington, D. C., and at additional mailing offices. POSTMASTER: Send address changes to Member Service Center, 2000 Florida Ave., NW, Washington, DC 20009, USA.

Member Service Center: 8:00 a.m.–6:00 p.m. Eastern time; Tel: +1-202-462-6900; Fax: +1-202-328-0566; Tel. orders in U.S.: 1-800-966-2481; Email: service@agu.org.

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Christine W. McEntee, Executive Director/CEO

AGU American Geophysical Union

Final Mirror Segment Added to Powerful Future Space Observatory

NASA/Chris Gunn

Inside a massive clean room at NASA Goddard Space Flight Center in Greenbelt, Md., the James Webb Space Telescope team used a robotic arm to install the last of the telescope mirror's 18 segments.

Construction of the large space telescope that is next in the Hubble Telescope lineage has reached two major milestones. Scientists and technicians at NASA Goddard Space Flight Center in Greenbelt, Md., recently installed and aligned the last of the 18 hexagonal segments of the infrared telescope's primary mirror, and they successfully completed a series of cryogenic tests on the telescope's instrument package.

"We have been, for years and years, leading up to this point of putting the [mirror] pieces together," Amber Straughn, an astrophysicist and deputy project scientist for science communications, said at a late January presentation at Goddard, where the mirror has been assembled and where the main instruments of the James Webb Space Telescope (JWST) have undergone exacting testing for the frigid space environment. Scheduled to launch in October 2018, JWST will orbit the Sun at the second Lagrange point, or L2, a location 1.5 million kilometers away from Earth that will allow the observatory to stay in a fixed position relative to Earth and the Sun. "For me, it finally looks like a telescope. It's so exciting to see the mirrors come together," Straughn said.

"Hubble has changed the way we understand the universe, and it has driven a lot of the science that we are planning to do" with JWST, explained Straughn. She added that the new telescope will be "about 100 times more powerful" than the Hubble Telescope, thanks to JWST's tennis court–sized mirror, the infrared wavelength range it will observe, and the efficiency of its set of instruments.

Key Science Themes

JWST "is going to completely revolutionize our understanding of exoplanets"—those distant planets that orbit stars other than our Sun—by helping scientists learn more about their atmospheres, Straughn said. JWST, which is an international project led by NASA with major contributions from the European Space Agency and Canadian Space Agency, could also observe the outer planets in our own solar system. However, the telescope's mirrors and instruments must point away from the Sun and Earth, which are large infrared sources that could "fry the detectors," she added.

JWST will also peer with infrared vision "beyond the veil of galaxies we see with Hubble," Straughn said. The telescope will scrutinize parts of the universe 13.5 billion light years away and therefore see them as they were that many billions of years ago. By looking back to almost the beginning of the universe, researchers hope to learn about the first stars and galaxies to appear after the big bang.

Scientists also anticipate that the observatory will help them better understand the evolution of galaxies, mysteries of star formation, and the birth of planetary systems, Straughn said, noting some of the observatory's science themes (see http://bit.ly/JWST-themes).

Top Priority for the Astronomical Community

JWST, formerly known as the Next Generation Space Telescope, ranked as the top priority of the astronomical community in the 2000 National Academy of Sciences decadal survey for astronomy and astrophysics (see http://bit.ly/Astro-Decadal). Its instrument suite includes JWST's primary imager, a near-infrared camera that covers infrared wavelengths from 0.6 to 5 micrometers. This camera can detect light from the earliest stars and galaxies, stars in nearby galaxies, young stars in the Milky Way, and Kuiper Belt objects. The instrument suite also includes a near-infrared spectrograph, covering the same wavelength range as the near-infrared camera; a mid-infrared instrument, with a camera and spectrograph, covering the wavelength range of 5 to 28 micrometers; and a near-infrared imager and slitless spectrograph, with a wavelength range of 0.8 to 5.0 micrometers.

Testing the Components

Those instruments underwent thermal tests early this year inside a space environment simulator facility at Goddard—a vacuum chamber where scientists and engineers lowered the temperature to 42 kelvins and below. In the meantime, scientists and technicians in white "bunny suits" inside a massive clean room at Goddard precisely assembled 18 gold-coated beryllium hexagonal segments to form the telescope's primary mirror. Each segment, protected from dust by a black carbon-composite cover, weighs about 40 kilograms. The assembled mirror spans 6.5 meters, 2.7 times the diameter of Hubble's mirror.

Next steps include more testing and assembly of all JWST components in preparation for its 2018 launch from French Guiana. For JWST project manager Bill Ochs, the complex deployment of the telescope after it reaches space promises to be nerve-racking, comparable in some ways to the 7 minutes of terror as NASA's Curiosity rover descended to the surface of Mars in 2012. "We have 3 weeks of high anxiety," he said. However, Ochs noted, the science should be "amazing" from JWST. "The things that we don't even know about that we'll find" could prove the most interesting, he said.

By **Randy Showstack,** Staff Writer

Scientists Denounce Pending Australian Climate Science Cuts

Australia's national research institute is drawing fire from scientists over plans to shift away from basic climate science. The plans would focus the agency on how to mitigate climate change and adapt to its impacts, such as the increasing risk of bushfires like the one shown here.

Climate scientists and their backers across the globe are decrying plans by Australia's national research institute to scale back its work on basic climate science in favor of research into coping with climate change.

Some 350 of roughly 5200 employees of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) could lose their positions and be replaced with hires in other research areas over the next 2 years as part of the plan by agency chief executive Larry Marshall. "The overall number of people in CSIRO is projected to be unchanged at the end of a 2-year period," Marshall said in a recent statement (http://bit.ly/Marshall_8_Feb).

Details Scarce

Details remain scarce on which specific climate research topics will shoulder the burden. But CSIRO officials have confirmed that the agency could reduce climate measurement and modeling staff by roughly half, with some of them potentially moving to outside research institutions.

Opponents of the proposal, which started to attract media attention in early February, have said it could severely curb the agency's basic climate science capabilities and hurt, not help, Australia's ability to respond to climate change. "It is a bad comment about Australia's scientific reputation," John Church, head of CSIRO's sea level rise program, told *Eos*. He has been speaking out strongly against the agency's proposed changes.

> Researchers are still trying to understand climate change's detailed workings and its effects, the statement said.

In a 4 February email to his staff, Sydney-based Marshall, an engineer and tech entrepreneur, wrote that the country was in need of science that could spur innovation in a changing global economy. He explained that the plans for CSIRO climate research reflected his assessment that researchers had already learned enough "to prove global climate change."

"That question has been answered, and the new question is what do we do about it, and how can we find solutions for the climate we will be living with?" said the message, obtained by the *Sydney Morning Herald* (see http://bit.ly/CSIRO_email).

Global Backlash

The proposal has since sparked a global backlash. The climate research wing of the World Meteorological Organization (WMO), a United Nations agency, condemned it.

"We read that these cuts occur in the name of innovation," said the statement from WMO's World Climate Research Programme (WCRP). "One can hardly imagine a worse and more backward step toward any of those laudable goals than ignoring climate and discarding climate research."

The WCRP found "most worrisome" Marshall's suggestion to shift toward climate impacts simply because researchers had resolved the issue of climate change's existence. Researchers are still trying to understand climate change's detailed workings and its effects, the statement said.

In another reaction to the pending changes, more than 2900 scientists signed a letter sent to CSIRO and Australian officials noting that the Paris climate agreement reached in December stressed the need to boost scientific knowledge on climate change. "CSIRO's decision to slash climate research will severely curtail Australia's capacity to deliver on these key promises," said the letter, obtained by *Eos*.

Praising Realigned Priorities

Some others have defended CSIRO's moves. Richard Colbeck, who is both an Australian senator with the ruling Liberal Party and a government minister involved with trade, investment, tourism, and international education, praised the "realigning of priorities."

"It's a really important thing that CSIRO [is] doing because it is researching actually how we manage the effects of climate change,"

such as more frequent and severe bushfires, he told the Australian Broadcasting Corporation (see http://bit.ly/Colbeck_ABC).

Marshall also justified the change of focus, stressing the need for research that spurs innovation. Marshall told an Australian Senate panel, whose proceedings were webcast, that he was "very surprised" by all the criticism, but he requested patience as CSIRO officials continued consulting with staff on the changes.

No Net Loss

He denied that CSIRO would suffer a net loss of staff, telling senators that some staffers would be retrained or reassigned to other institutions and additional ones hired in other research areas. He also noted that CSIRO accounts for just 16% of Australia's environmental research capacity.

He asserted that CSIRO would continue running its Cape Grim station for greenhouse gas monitoring and other programs for studying ocean conditions, as well as maintain its climate models. And he stressed that CSIRO would find ways to keep gathering data with fewer staff, such as by crowdsourcing refinements to its models and deploying autonomous underwater vehicles into the oceans.

Church, however, suggested that the quality of work might suffer with fewer scientists. "In that sense, his statement is misleading," Church said.

> Officials have confirmed that the agency could reduce climate measurement and modeling staff by roughly half.

Risky Maneuvers?

John Connor, CEO of the Climate Institute of Australia, a nonprofit advocacy group working against climate change, warned that shifting staff and projects to other research institutions could carry its own risks. Other institutions are continually competing for limited—and, more recently, declining—government funding, he said in an interview. "We would counsel against a quick fix which leaves those capabilities exposed to future sorts of financing challenges," he said.

Senator Kim Carr of Australia's Labor Party echoed these concerns at the Senate panel hearing. "Who has the capacity that matches anything like the CSIRO does in these areas and has the security of funding?" Carr asked.

CSIRO deputy chief Craig Roy, without offering specifics, responded that the agency has made a commitment "to maintain the facilities."

By **Puneet Kollipara,** Freelance Writer; email: puneet.kollipara@gmail.com

Editor's Note: See the Editors' Vox *blog post (http://bit.ly/EVox_CSIRO) by Susan Trumbore, editor in chief of* Global Biogeochemical Cycles, *for additional perspectives on this news.*

Climate Change Freezes Mountain Wildflower Reproduction

Zachariah Gezon

As snow melts earlier because of climate change, the dates when western spring beauty plants flower have also advanced. New research finds that this earlier blooming subjects the plant to frost damage to plant tissue and to diminished reproductive success.

Climate change's manipulation of global temperatures is causing glaciers to recede, icebergs to calve, and the yearly snowpack to melt earlier. But how do such changes influence life? A recent study investigated this, focusing on how early snowmelts, and therefore flowering times, affect the reproductive success of mountain plants.

To study how mountain plants react to the shifting calendar of snow disappearance, a team led by Zachariah Gezon, then a graduate student at Dartmouth University in Hanover, N.H., studied the western spring beauty wildflower (*Claytonia lanceolata*) from 2011 through 2013. This plant typically emerges soonest among those that sprout on the Rocky Mountains during the spring thaw.

The researchers found that when snow disappears earlier, these plants have less success reproducing. However, the reproductive harm resulted from frosts damaging the tissues of early appearing blossoms rather than from any dearth of pollinators when the flowers opened ahead of schedule.

Simulating an Early Melt

Gezon conducted this study in western Colorado as part of his doctoral dissertation. He and student volunteers set up plots near the Rocky Mountain Biological Laboratory, which is just north of Crested Butte, Colo. The plots were laced with tubers of spring beauty plants.

> Plants that grew in plots freed from snow flowered 10 days earlier than plants not in the plots where snow was removed.

To simulate an early snowmelt, Gezon, who is now a conservation biologist with Disney's Animal Program, cleared the 4-meter-square plots of snow when there was up to a meter of snow left on the ground. This snow removal triggered an early flowering response from the plants that soon grew from the tubers, similar to what would happen if climate change advanced plant flowering times earlier than when the plants normally produce blossoms. Across the 3 years of the study, he observed that on average the plants that grew in plots freed from snow flowered 10 days earlier than plants not in the plots where snow was removed.

Double Threat

Early flowering plants face two main challenges as a warming climate toys with the environmental factors that trigger plant growth, Gezon explained. A timing mismatch might occur between when the plant's flowers open and when pollinators are present, leaving the plants healthy but unable to fertilize each other. Or plants might flower before the last frosts have taken place, subjecting the delicate blossoms to destructive freezing that renders the plants' reproductive tissues useless.

Gezon found that although he had advanced the spring beauty's flowering time, abundant pollinators, in this case sweat bees, buzzed between plants. However, frosts later hit the plants hard, preventing the damaged plants from reproducing. He and his coauthors reported their findings on 1 February in the journal *Global Change Biology* (see http://bit.ly/Spring-Beauty-study).

"It doesn't take much frost damage to severely reduce plant reproduction," said Gezon. "Regardless of how much the pollinators visit the plants, if you get hit by frost, you just can't reproduce."

Greenhouse Growth Check

Removing snow from the plots alters the moisture of the soil and how much water is available to plants. To confirm that frosts, not soil moisture changes, were responsible for the reproductive declines the team observed, Gezon raised some spring beauties until they flowered in a greenhouse during the last year of the study and then transplanted them into a snowy area of his field study site. Regardless of whether the authors followed the greenhouse or snow removal methodology, episodes of frost left the earlier flowering plants unable to reproduce, Gezon said.

"The results presented here really suggest frost is the bigger problem for plants that bloom earlier than usual" instead of a timing mismatch with pollinators, said Jessica Forrest, a pollination ecologist and assistant professor at the University of Ottawa in Canada, who was not involved in the study. The finding isn't entirely novel, but field results clarifying which factor prevails have been scarce, she noted.

By **Cody Sullivan,** Writer Intern

Court Delay on U.S. Climate Plan Won't Stop Clean Energy Efforts

A recent decision by the U.S. Supreme Court to hold up implementation of the Obama administration's Clean Power Plan (CPP) neither kills this key element of the president's actions against climate change nor slows down clean energy efforts, argued several former governors and other experts at a late February forum at the Brookings Institution in Washington, D. C. However, they said the decision adds uncertainty for state and utility planning and raises questions about international efforts to meet climate change goals.

The stay granted by the court on 9 February, in a 5–4 decision, puts on hold until further judicial review the plan formulated by the U.S. Environmental Agency (EPA) for states to reduce carbon dioxide from existing fossil fuel–fired electric generating units (see http://bit.ly/CleanPP). The one-paragraph stay provided no explanation for the court's decision, which was made prior to the death of Justice Antonin Scalia, who voted with the majority.

jzehnder/Adobe Stock

A U.S. Supreme Court–ordered stay has stalled a federal plan to limit emissions of carbon dioxide from power plant smokestacks like these.

A Dramatic Event

The court decision "was a pretty dramatic event," said former Colorado governor Bill Ritter at the forum. Ritter, director of the Center for the New Energy Economy at Colorado State University in Fort Collins, said the plan "provides a great framework for dealing with greenhouse emissions, and it will provide great momentum for us as a nation to move forward and actually meet our [emission] targets" declared at last year's climate summit in Paris. States will continue "to look at how they decarbonize" even if the CPP were to go away, he said, adding that the country is in the midst of an energy revolution that is "about planning for a carbon-constrained future."

> "There are a lot of challenges that are still going to bring people to the table, although that table may not be organized specifically around the Clean Power Plan."

Although some states have opted to stop or slow down CPP-related measures until there is judicial clarity, said Christine Todd Whitman, who was formerly the New Jersey governor and the EPA administrator, "states are going to, for a large part, go ahead and continue to move toward some kind of clean carbon economy." Whitman, cochair of the Clean and Safe Energy Coalition, added that utilities and companies, including those operating internationally, need certainty in regulations for planning purposes.

Although state utility commissioners take differing positions related to the Clean Power Plan, "the conversations concerning clean energy resources and economic development within states [are] going to continue unabated," according to Greg White, executive director of the National Association of Regulatory Utility Commissioners, which is based in Washington, D. C. The CPP "was simply accelerating the time frames" at which an "evolutionary move towards cleaner energy technologies" was taking place, he said.

Plan Sparked Discussion

The plan has been "a forcing mechanism" to bring utility and air quality regulators and affected stakeholders to the table to discuss what the future of the electricity sector should be, said Jonas Monast, director of the Climate and Energy Program at Duke University's Nicholas Institute for Environmental Policy Solutions in Durham, N.C. "There are a lot of challenges that are still going to bring people to the table, although that table may not be organized specifically around the Clean Power Plan."

Several speakers suggested that the CPP may not be essential to accelerating emissions cuts. According to Josh Linn, senior fellow at Resources for the Future, a think tank in Washington, D. C., carbon dioxide emissions from the power sector have been declining and may continue to do so even without the CPP. The plan "requires emission reduction at a slower rate of decrease than we've already seen," he said.

By **Randy Showstack,** Staff Writer

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Precipitation Data Key to Food Security and Public Health

2015 Global Precipitation Measurement (GPM) Mission Applications Workshop
Hyattsville, Maryland, 9–10 June 2015

Marisol Grandon/UK DFID, CC BY 2.0 (http://bit.ly/ccby2-0)

A woman scoops water in a dry riverbed in northern Kenya. Lack of rain led to drought and a severe food crisis that threatened the livelihood of more than 13 million people across the Horn of Africa in 2011.

Satellite precipitation data are essential to weather forecasting, agricultural modeling, and emergency response planning. NASA's Global Precipitation Measurement (GPM) mission helps to provide these data.

GPM is a constellation of domestic and international satellites that estimate rainfall and snowfall every 3 hours. The constellation is centered around the GPM Core Observatory satellite, which was launched by NASA and the Japan Aerospace Exploration Agency in February 2014. The Core Observatory unifies data from partner satellites by serving as a reference by which each instrument can be calibrated. GPM is a follow-on to NASA's Tropical Rainfall Measuring Mission (TRMM), which collected precipitation data for more than 17 years.

NASA's GPM and TRMM missions hosted a workshop in June 2015 in Hyattsville, Md., to discuss how the GPM applications program can better address the needs of the different sectors of the community. More than 125 people from government agencies, academia, the private sector, and international organizations participated in the meeting. Researchers, government officials, and representatives from private companies and nongovernmental organizations described how the data were being used in forecasting and responding to a range of issues that impact the globe.

> Near-real-time satellite data are critical for better understanding the spread of vector-borne and waterborne diseases.

Panelists from the food security and agriculture communities emphasized how GPM and other rainfall data are key to better understanding our use of water resources and its implications for food security. For example, the Famine Early Warning Systems Network, created by the U.S. Agency for International Development, provides early warning and analysis of acute food shortages to help decision makers and relief agencies plan for and respond to humanitarian crises.

Panelists also discussed how satellite data on current rainfall and long-term precipitation patterns allow researchers to compare a current drought with past droughts and to model the extent of potential impacts. For example, visualizations of rainfall accumulation over the United States from month to month as observed by GPM can help communities manage water resources and floods.

Public health and ecology researchers provided examples of how near-real-time satellite data are critical for better understanding the spread of vector-borne and waterborne diseases. Ben Zaitchik of Johns Hopkins University described using TRMM and GPM data to track malaria in the Amazon by identifying the key environmental factors for mosquito breeding sites. Antar Jutla of West Virginia University discussed the link between precipitation and temperature in creating an environment for diarrheal diseases, specifically cholera.

TRMM and GPM precipitation data are also important for disaster response and monitoring organizations, enabling them to better prepare and react to evolving natural disasters and global crises. Chris Chiesa from the Pacific Disaster Center demonstrated the center's DisasterAWARE portal (http://bit.ly/DAWARE), where TRMM and GPM data are routinely used to provide situational awareness for active disasters around the world.

The main themes outlined at the workshop focused on data availability, resolution, and consistency. The Integrated Multi-Satellite Retrievals for GPM (IMERG) product provides high spatial and temporal precipitation data that are available within 4–6 hours of a weather event. Users expressed great interest in this product but also emphasized the need for a consistent, long-term record with which to validate models or compare current rainfall totals to historical events.

The GPM Applications team is addressing the workshop participants' comments and is always interested in additional feedback from the community. For more information and speaker presentations, please visit the workshop's website (http://bit.ly/GPMWrkshp).

By **Dalia Kirschbaum** and **Kasha G. Patel,** NASA Goddard Space Flight Center, Greenbelt, Md.; email: dalia.b.kirschbaum@nasa.gov

Creating Local Support Networks for Graduate Student Women

Women remain underrepresented in the science, technology, engineering, and math (STEM) workforce inside and outside of academia [*National Science Foundation*, 2015]. We are women graduate students in STEM, and we have seen our female colleagues drop out of STEM fields during and just after graduate school, creating leaks in the pipeline toward academic and nonacademic jobs.

Although gender bias exists at all levels in academia, specific biases hurt women graduate students in particular. As trainees, women graduate students are more likely to experience sexual harassment and assault in the field [*Clancy et al.*, 2014], and women graduate students have been the targets of recently publicized sexual harassment by professors at universities across the country [*Marín-Spiotta et al.*, 2016].

Students tend to rate male assistant instructors more highly than female assistant instructors regardless of abilities [*MacNell et al.*, 2015], and letters of recommendation for female students may be more likely to contain inappropriate and inapplicable information, such as personality descriptors as opposed to skill and intelligence level [*McNutt*, 2015]. Male and female faculty members also exhibit hiring biases against female applicants for positions such as lab managers [*Moss-Racusin et al.*, 2012].

Because we feel strongly that issues for women and other underrepresented groups in STEM should be addressed, we established the Northern Colorado chapter of Graduate Women in Science Science (GWIS; http://bit.ly/Colo_GWIS) in fall 2014. Our organization's goal is to promote women of all ages and backgrounds in STEM fields through community support, professional networking, and mentoring opportunities. We wish to share what we have learned, which is particular to graduate student women but is applicable to STEM women at all levels.

In our first year, we organized panels on women in scientific careers and networking (some cosponsored by the AGU Hydrology section), held social events, and advocated for paid parental leave for graduate student employees at our institution. Through our activities, we learned to help one another become more confident in our career paths and more aware of the biases we currently face and may encounter in the future. Here we provide our perspective on issues facing many graduate women in STEM and describe some strategies to overcome barriers to success.

Sara Rathburn

Graduate students Annette Patton (Colorado State University) and Claire Lukens (University of Wyoming) collect rock samples for beryllium-10 radionuclide analysis.

Feeling Like Impostors

Despite the successes of our group members, as we engaged in activities, it became clear that many of us lacked confidence and sometimes felt like impostors in our fields. All graduate students can experience feelings of inadequacy, but women and other underrepresented groups may feel this more strongly. Women tend to lack confidence in their abilities, at times attributing their success to luck instead of taking ownership of their successes (as summarized in *Kay and Shipman* [2014]).

In addition, women and underrepresented groups are disproportionately affected by negative talk in academia [*Twale and De Luca*, 2008], such as unnecessarily harsh criticism of a graduate student's research. We heard these perspectives and experiences from panelists—successful women well established in STEM careers—and group members.

Striking a Professional-Personal Balance

Panelists and group members also expressed concerns about professional-personal balance in graduate school and professional arenas. Some in our group plan to move on to jobs in academia, whereas others seek careers in government, nonprofit organizations, or the private sector. For those with academic aspirations, getting tenure while starting a family is particularly concerning. However, many of our group members and panelists discussed the difficulty of balancing children and professional success regardless of which path they took, or hoped to take, in their careers.

Several of the STEM women we hosted for our panels noted that they didn't realize what their options were for professional-personal balance before they began their careers. They described successfully negotiating and asking for what they needed from an employer or department (e.g., working from home 1 day a week), resulting in a better balance between their personal and professional lives.

The lesson is clear: Let's not take ourselves out of the game too early. If we aspire to careers as field or lab scientists at competitive research institutions or at government agencies but know that we hope to have families, we shouldn't give up too early on either—we

Without this diversity of perspective, science is missing out on the unique contributions that different groups can provide.

won't know what is possible unless we try. As highlighted in many recent discussions in the news and online, many people, regardless of gender, are concerned about having families or full personal lives, with or without children, while working. Although we recognize that social norms and institutional policies need to change to create work environments that promote balance and support for everyone, we can all actively advocate for positive changes from within science organizations and institutions

Our group has tried to practice support for professional-personal balance in informal ways through conversations with each other. We are also formally advocating for paid parental leave for all graduate student employees at Colorado State University, where most of our members are graduate students. Similar university-wide policies providing 6–8 weeks of paid parental leave have been implemented at many institutions across the country, including some of our university's peer institutions (Michigan State University, North Carolina State University, University of California, Davis, and others). We have started a necessary conversation about this issue on our campus, and we hope that a policy will be implemented within the coming year.

Taking Ownership of Our Successes

We are learning to help each other take ownership of our successes and identify ways to internally challenge feelings of inadequacy. This can take the form of recognizing and questioning situations in which we are irrationally undercutting ourselves or others. These feelings are common when considering our prospects for a particular job interview or prior to doctoral qualifying exams, class tests, and conference presentations.

We find it helpful to remind our colleagues and peers that when they experience these unjustified feelings, they should challenge the feelings internally. Strategies include pointing out to these peers when they are attributing their success solely to luck as opposed to luck and abilities.

We also find that we can facilitate taking ownership of our successes by shifting focus from "How can I be enough?" to "What do I need in order to succeed, and how can I create the outcomes that I believe in?" Seeking out the resources we need for success—a new and supportive committee member, a new or altered component to a dissertation, or perhaps even a change in career—redirects the energy from critiquing ourselves into getting the necessary support to engage fully in our communities and disciplines.

Strong Mentorship to Advance Our Careers

In our discussions, we also focus on the benefits of strong and positive mentorship. Our panelists have pointed out that sometimes the best mentors are those who are only a year or two ahead of us in graduate school because they remember clearly what it is like to be in our position. Studies and initiatives on mentoring for women in STEM fields are gaining momentum—such as Colorado State University's recently launched recruitment and retention research [*Rolston*, 2014] and the organization Million Women Mentors (see https://www.millionwomenmentors.org).

Regardless of where our mentors are in their careers, we shouldn't be afraid to seek out additional mentors, even in different departments or professions. We can have mentors for different aspects of our work, such as for seeking professional-personal balance or for obtaining proposal funding. We should learn to take our mentoring needs seriously rather than telling ourselves that we need to "toughen up" or learn to live with our situation.

Addressing Underrepresentation in STEM

Women graduate students in STEM are at a unique and decisive point in their careers. Our Northern Colorado GWIS chapter has become a support network for helping each other in times of need, regardless of what that need might be. We help each other learn new professional skills, advance our research, get through stressful or uncomfortable fieldwork situations, and manage difficult professional relationships.

Many of us are members of online networks that aim to support women in science, such as the excellent Earth Science Women's Network (ESWN; http://eswnonline.org/). ESWN and the Association for Women Geoscientists hosted a town hall meeting at AGU's 2015 Fall Meeting to discuss the role of scientific societies in addressing sexual harassment [*Marín-Spiotta et al.*, 2016]. However, having a local support network with face-to-face events and interactions is extremely beneficial. Our local group can also forge face-to-face connections in our region and elsewhere, for example, by cohosting events with the AGU Hydrology section at the AGU Fall Meeting.

Diversity in science is important for the sake of social justice and equal opportunity, and we also recognize the value that diversity in race, gender, ethnicity, and other aspects can bring to the advancement of science. Without this diversity of perspective, science is missing out on the unique contributions that different groups can provide. For example, the presence of women in a group greatly improves group collaboration, which is increasingly important to scientific innovation [*Bear and Woolley*, 2011]. Women scientists perform more interdisciplinary collaborations compared to male scientists [*van Rijnsoever and Hessels*, 2011].

Furthermore, women in leadership positions can act as mentors for students who are interested in pursuing STEM careers, thus increasing the diversity of future research. The support, mentorship, and collaboration provided by groups such as ours can improve the campus environment for STEM women. We believe that if others also start conversations about supportive environments in the workplace, we can move one step closer to a time when gender does not influence career success.

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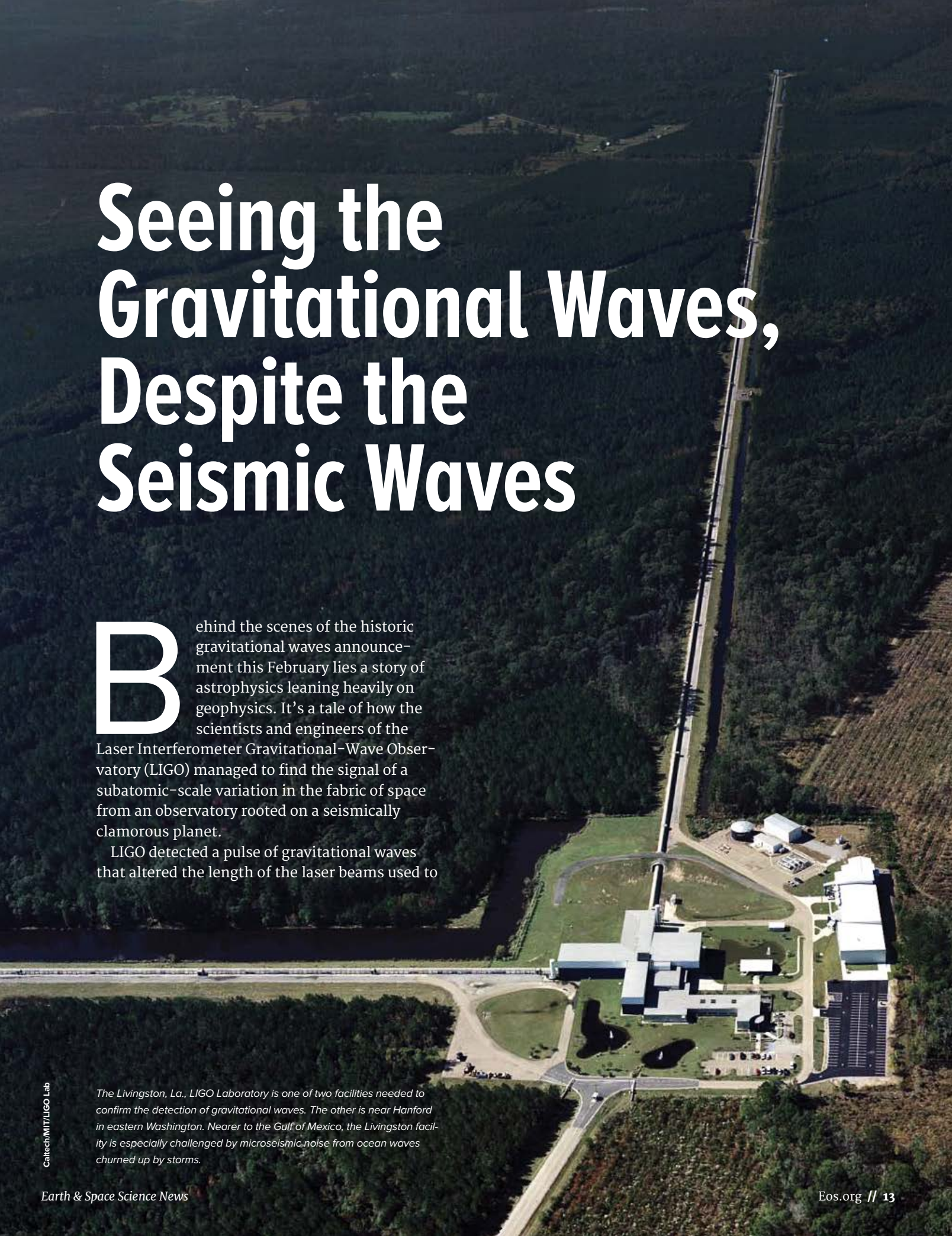
Seeing the Gravitational Waves, Despite the Seismic Waves

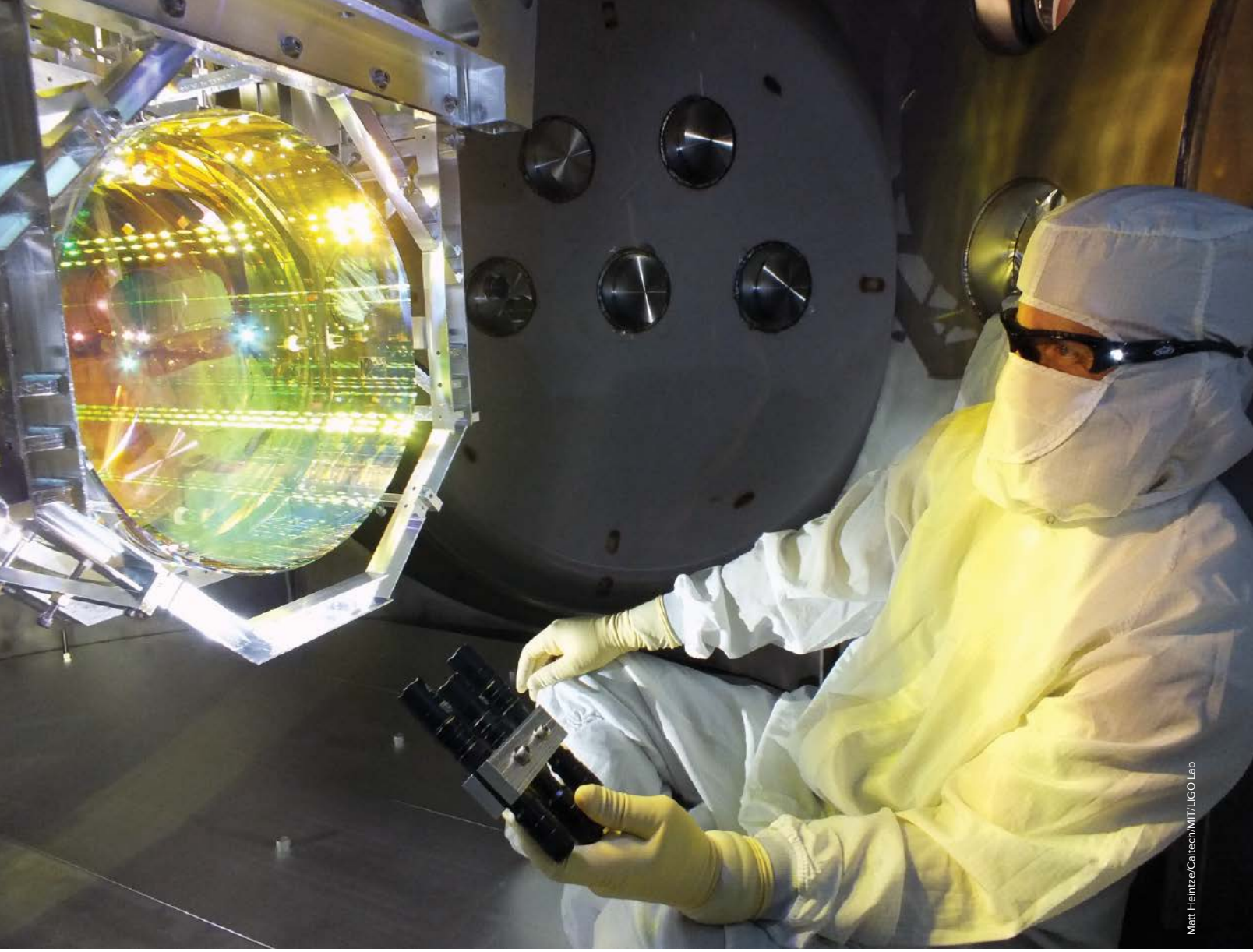
Behind the scenes of the historic gravitational waves announcement this February lies a story of astrophysics leaning heavily on geophysics. It's a tale of how the scientists and engineers of the Laser Interferometer Gravitational-Wave Observatory (LIGO) managed to find the signal of a subatomic-scale variation in the fabric of space from an observatory rooted on a seismically clamorous planet.

LIGO detected a pulse of gravitational waves that altered the length of the laser beams used to



Caltech/MIT/LIGO Lab

The Livingston, La., LIGO Laboratory is one of two facilities needed to confirm the detection of gravitational waves. The other is near Hanford in eastern Washington. Nearer to the Gulf of Mexico, the Livingston facility is especially challenged by microseismic noise from ocean waves churned up by storms.



Laser Interferometer Gravitational-Wave Observatory (LIGO) Livingston optics technician Gary Traylor inspects one of LIGO's mirrors by illuminating its surface with light at a glancing angle. This mirror is isolated from seismic noise by seven layers of springs, actuators, and pendulums.

measure the two 4-kilometer arms of the project's two facilities by an absurdly small amount.

"We quote some crazy numbers: 10^{-19} meters," said Anamaria Effler, a LIGO researcher at the California Institute of Technology (Caltech) in Pasadena. That's a ten-thousandth of the diameter of a neutron. How can they find that needle in Earth's seismological haystack? Sometimes they can, and sometimes they can't.

The Need to Control Seismic Noise

The ripples in space time that caused the pulse emanated from the collision of two black holes 1.3 billion light years away that had circled each other and then suddenly merged, a team of scientists announced on 11 February. The first step to detecting that colossal, but exquisitely far away, event lay in controlling seismic noise by locating the two LIGO detectors in relatively quiet places.

"We of course benefit with the lower seismic noise of the sites," said Peter Fritschel, senior research scientist at the LIGO Project at the Massachusetts Institute of Technology in Cambridge. "But we can't put them in the middle of nowhere," he added, because they need to be accessible to people who work on them. One resides near Richland, Wash., and the other near Livingston, La. So seismic noise from human activities creates interference in both of these areas.

Playing Keep Away

To isolate the LIGO detector's core optics from seismic jitters, multiple layers of springs, actuators, and pendulums counteract vibrations and dissipate seismic noise. Seismic isolation begins with a spring-mounted framework resting on the ground. On it stands the second stage: a double-decker platform, with each deck suspended from springs and other controls. This stage 2 also includes three broadband seismometers and six geophones for monitoring seismic noise.

From the center of stage 2 hang the mirrors that reflect the lasers used to detect changes in the lengths of the arms of LIGO. The mirrors dangle from the end of a quadruple pendulum, which, as its name implies, hangs in turn from a second pendulum hanging from a third pendulum, all of which are suspended from the second stage platform. Add up all those layers and pendulums, integrate them with computer controls, and you get seven stages of isolation of LIGO's optics from the Earth's trem-

ors. That knocks those jitters down by a factor of more than a billion, explained Stanford University's Brian Lantz, lead scientist for the Advanced LIGO Seismic Isolation subsystem.

Quakes, Storms, and Wind: Oh, My!

All that technology, however, can't always hold off an uncooperative planet.

"There are still things to work on in battling the seismic environment," said Fritschel. Earthquakes can overwhelm the instrument, microseisms from ocean waves can invade its target bandwidth, and even the wind blowing on the LIGO buildings can pose a challenge.

"Earthquakes will simply knock us out, and we have to wait for Earth to stop ringing," said Effler. Storms in the Gulf of Mexico can create so much noise that LIGO researchers in Louisiana just have to go home and wait it out, she said. Even the wind blowing on the buildings at the Washington State site can create too much seismic noise.

"Another thing we are still working on is resistance to earthquakes," said Fritschel. Even a few seconds' warning of incoming seismic waves from a quake would make LIGO a lot more robust, he said.

Ultimately, there will always be some bands where ground-based gravitational wave observatories just can't observe, said Fritschel.

In LIGO's current configuration, if its instruments experience shaking slower than 10 cycles per second, the pendulums can't cancel it out. The remedy for this deaf zone in LIGO's gravitational hearing is the same one sought by astronomers endeavoring to explore the universe in X-rays and other wavelengths that don't reach Earth's surface: observe from space. To fill that void, LIGO's cousin has been under development: the Laser Interferometer Space Antenna (LISA). Not only will LISA (or its kind) not be limited by seismic noise, but it will easily have greater arm lengths, which will enable the instruments to detect even subtler quivers in the fabric of space and time (see http://bit.ly/LISA-Pathfinder).

Detectors on Earth and in Space

LISA will likely only complement, not replace, ground-based observatories like LIGO, which means the marriage of geophysics and astronomy is likely to go on for a while.

"Geophysicists are very good at listening to the ground," said Lantz. "We're very happy to be working with geophysicists on this."

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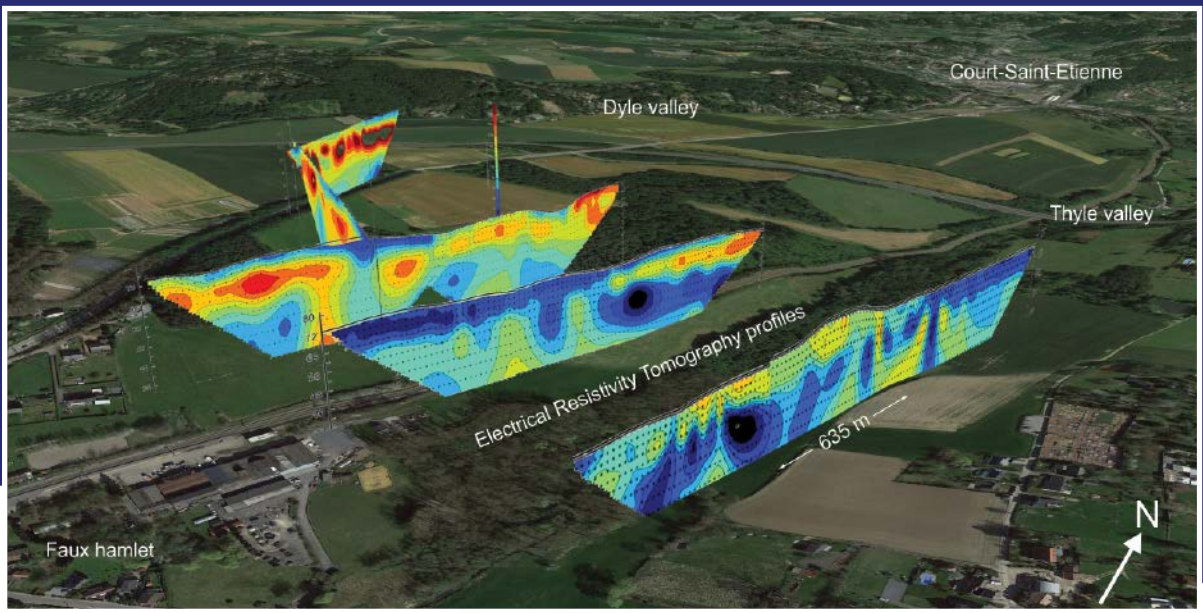
VISUALIZING CROSS-SECTIONAL DATA IN A REAL-WORLD CONTEXT

By Koen Van Noten

Combining the capabilities of an open-source drawing tool with Google Earth™ maps allows researchers to visualize real-world cross-sectional data in three dimensions.



*Parallel and crossing two-dimensional electrical resistivity tomography profiles obtained in search of potential surface expressions of the 2008–2010 seismic swarm in the Brabant Massif, Belgium [*Van Noten et al., *2015]. Source: "Court-Saint-Etienne" 50.6245°N, 4.5527°E. Google Earth™. Satellite photo taken 18 April 2015. Image captured 2 September 2015. Eye altitude 407 m. DigitalGlobe 2015.*

If you could fly around your research results in three dimensions, wouldn't you like to do it? Visualizing research results properly during scientific presentations already does half the job of informing the public on the geographic framework of your research. Many scientists use Google Earth™ mapping service (V7.1.2.2041) because it's a great interactive mapping tool for assigning geographic coordinates to individual data points, localizing a research area, and draping maps of results over Earth's surface for displaying the results in three dimensions. Yet scientists often do not fully explore the Google Earth™ platform.

Visualizations of research results in vertical cross sections through these maps are often not shown at the same time as the maps. However, a few tutorials to display cross-sectional data in Google Earth™ do exist, and the workflow is rather simple. By importing cross-sectional data into in the open software SketchUp Make [*Trimble Navigation Limited*, 2016], any spatial model displaying research results can be exported to a vertical figure in Google Earth™. Here I explain an easy workflow, give some tips, and discuss some of the endless applications of the method. This workflow will give your research results better spatial visibility and allows more dynamic scientific presentations.

What You'll Need

The only programs necessary to display results are the open software three-dimensional (3-D) drawing tool SketchUp Make and Google Earth™. SketchUp Make is mostly used for creating representations of buildings in three dimensions that can be explored in Google Earth™

when the 3-D building layer is toggled on.

By importing a cross section into SketchUp Make, any spatial model displaying research results can be exported to a vertical figure in Google Earth™ to enable the results to be visualized spatially. These representations are, for instance, used by NASA to plot cloud formations above Earth [*Chen et al.*, 2009]. The usefulness of the proposed workflow in this short tutorial lies in its simplicity. No external scripts linked to any specific programming language are needed.

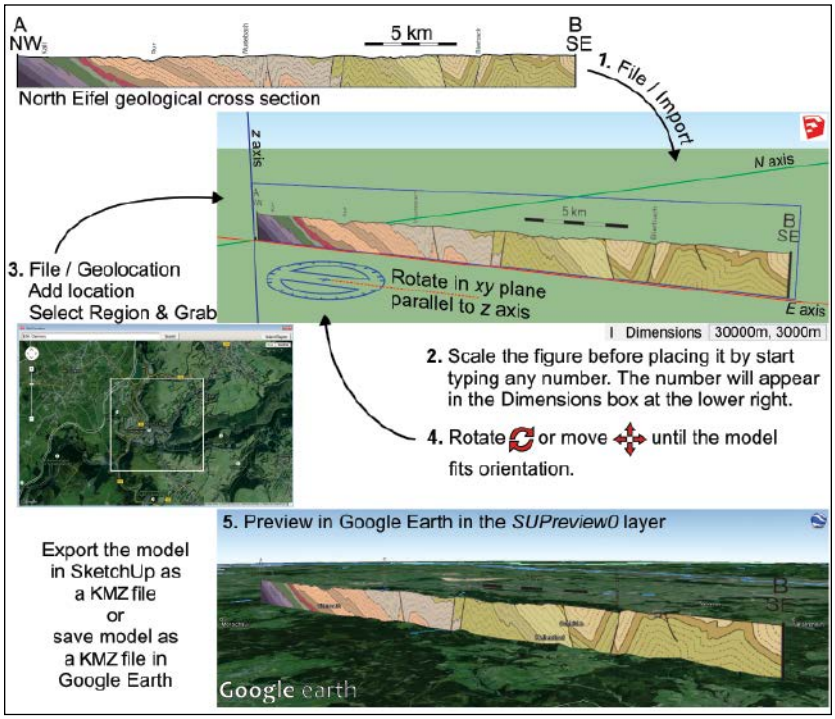


*Fig. 1. Five-step workflow for setting up and exporting a vertical cross section from SketchUp Make into Google Earth™. Example shows a 30-kilometer-long, northwest-southeast geological cross section through the North Eifel mountains in Germany [*Van Noten et al. *2011]. Source: "NW Eifel" NW coordinates = 50.6166°N, 6.2511°E; SE coordinates = 50.3982°N, 6.5001°E. Google Earth™. Satellite photo taken 2 August 2007. Image captured 7 July 2015. Eye altitude 2.21 km. DigitalGlobe 2015.*

How to Do It

For maximum visibility, the Portable Network Graphics (PNG) picture format is preferable for your figure. This format allows the background of the vertical cross section to be transparent, which is far more useful than the white background in JPEG or other formats.

The workflow is as follows (a video tutorial with a more complete description and the Google Earth™ image example described below are available at http://bit.ly/Van_Noten_Xsection):

1. Import the figure into SketchUp Make under File/Import and drag it vertically (parallel to the *z* axis, shown in Figure 1).

2. Before clicking any mouse button to place the imported model, the figure needs to be scaled properly. Specify the exact dimension by typing the dimension immediately after having imported the figure. Any numbers you enter will appear at the bottom right in the Measurements. Input the written height and width dimensions separated by a comma or semicolon, depending on local system settings (e.g., 30000m, 3000m). The figure can always be rescaled manually, after the model is placed, by using Tools/Dimension or Tools/Scale.

3. Geolocation of the figure (File/Geolocation/Add Location) might take some time and practice but is necessary to locate the figure properly when it is exported to Google Earth™. Select Region either by browsing for the location manually or by typing the nearest place or coordinates of location. Subsequently, Grab the location. Although the area that can be grabbed is rather limited, the area size is not that important because the model will be exported entirely into Google Earth™ in step 5.

4. The final step consists of moving (Tools/Move) and rotating (Tools/Rotate) the figure to the exact orientation of the cross section. The rotation angle can be manually input once the rotation axis is defined (e.g., rotation of the imported figure in the *x*–*y* plane with the rotation axis parallel to the *z* axis), or the orientation can be modified in Google Earth™ after step 5.

5. The figure can now be uploaded in Google Earth™ (File/Preview in Google Earth™), where a new model SUPreview0 will appear in the Temporary Places. It might take a few tries to get the figure into its proper position, either by going back and forth between the two programs or by modifying the location of the model directly in Google Earth™ via the properties of the model (slightly easier than going back and forth). Note that the Preview option is no longer available in SketchUp Make 16 (release 2016), so you might consider installing an earlier SketchUp Make version or avoiding step 5 and going directly to saving your model (explained below).

Exporting and Saving the Model

The downside of this method is that Google Earth™ can handle only one preview export from SketchUp Make at a time because the preview model will always end up in the same SUPreview0 in Google Earth™. This might be annoying for the user because new uploads from SketchUp Make will overwrite previous exported figures, even when the model was saved in the My Places layer in Google Earth™ and even if the layer was renamed.

Overwriting cannot occur if the model is exported or saved to a KMZ file extension, i.e., the Google Earth™ placemark file. Once a satisfactory result has been reached, it is advisable to either export the 3-D model to

a KMZ file in SketchUp Make (if this was your last step) or save your model to a KMZ file in Google Earth™ (if your last step was to change the orientation of the profile via the properties of the model). Reopening the KMZ file from your computer's file directory will show your results properly, and you can drag your model to the My Places folder in Google Earth™.

Some Words of Advice

If a vertical exaggeration (e.g., factor 2) is to be used in Google Earth™, this has to be taken into account when positioning the model. Exaggeration of high-relief areas might render the model invisible in Google Earth™, as your model will be situated below the exaggerated topography. An easy solution to account for this problem is to move (Tools/Move) the model in SketchUp Make along the *z* axis until it appears in Google Earth™ by moving back and forth between the two programs or by modifying the height of the model via the properties of the SUPreviewo model in Google Earth™.

Use caution when applying the method for displaying very deep cross sections, e.g., several hundreds of kilometers to demonstrate crustal changes in Earth. If the vertical scale is too large, one may visually lose the connection with Earth's surface. Rescaling the *z* axis of the figure would then be the best way to show results properly.

Cross-sectional data are meant to interpret Earth's structure. Unfortunately, Google Earth™ does not allow users to "cut" parts out of Earth to place your cross section "in" Earth to show crustal properties of inner Earth. This might be a new tool in the future, but for now, the proposed visualization tool is the best solution geologists have.

Applicability

Although this workflow demonstrates how one vertical cross section can be displayed, the applications of visualizing results by using SketchUp Make are endless. Instead of importing one rectangular profile, one can easily import numerous parallel and crossing figures to create a semi-3-D effect (e.g., the image at the beginning of this article), a circular model, or any random figure fitting the representation of the research results.

Models can also be rotated along the horizontal axis to display changes, e.g., along valley or volcano flanks. For large global representations, figures might need to be separated into several parts or curved to account for the curvature of Earth (Figure 2).

This visualization tool does not need to be restricted to geology. Photographs or any parameter that varies with distance can be represented vertically. Once your model is exported to Google Earth™, you can fly around it, export the various views, or make a fly-through movie and impress your audience during your next conference presentation.

Acknowledgments

The editors, an anonymous reviewer, M. E. Cushing, and M. Van Camp are thanked for their suggestions on the paper. T. Lecocq, J. Molron, A. Watlet, and A. Triantafyllou are acknowledged for testing the workflow. K.V.N. is supported by the Fonds de la Recherche Scientifique (Belgium) under grant PDR T.0116.14.

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Unmanned Platforms Monitor the Arctic Atmosphere

By Gijs de Boer, Mark D. Ivey, Beat Schmid, Sally McFarlane, and Rickey Petty

Gijs de Boer

A DataHawk UAS (1-meter wingspan) completes low-altitude flights at Oliktok Point during the Evaluation of Routine Atmospheric Sounding Measurements using Unmanned Systems campaign, with the mobile research facility AMF-3 in the background.

In the Arctic, drones and tethered balloons can make crucial atmospheric measurements to provide a unique perspective on an environment particularly vulnerable to climate change.

Climate is rapidly changing all over the globe, but nowhere is that change faster than in the Arctic. The evidence from recent years is clear: Reductions in sea ice [*Kwok and Untersteiner*, 2011] and permafrost [*Romanovsky et al.*, 2002], in addition to modification of the terrestrial ecosystem through melting permafrost and shifting vegetation zones [*Burek et al.*, 2008; *Sturm et al.*, 2001], all point to a rapidly evolving Arctic climate.

However, the ability of numerical climate models to capture the dynamics of the Arctic still needs improvement. For example, several recent studies have demonstrated deficiencies in the representations of clouds in climate models [e.g., *de Boer et al.*, 2012]. Models also struggle with simulating stable atmospheric boundary layers [e.g., *Steeneveld et al.*, 2006], as well as simulating Arctic aerosol properties and their effects on how clouds alter the transfer of energy through the atmosphere [*English et al.*, 2014].

To improve these models, scientists have started flying unmanned aerial systems (UAS)—commonly known as drones—and tethered balloon systems (TBS) to collect measurements of

Gijs de Boer prepares to launch a DataHawk unmanned aerial system (UAS) at Oliktok Point campaign, while Jack Elston prepares to pilot the aircraft. Both scientists were involved with the Coordinated Observations of the Lower Arctic Atmosphere (COALA). The Sandia tethered balloon system is flying in the distant background.

the atmosphere, cryosphere, ocean, and land surface. These platforms show great promise in collecting three-dimensional data sets at resolutions that climate scientists have never before been able to obtain.

However, to ensure public safety, the Federal Aviation Administration (FAA) currently limits general operations of these platforms, sometimes curtailing their utility for scientific research. To enable research on processes important to climate change in the Arctic—those involving aerosol particles, clouds, and the surface energy budget—the U.S. Department of Energy (DOE) supports the Oliktok Point measurement facility, which includes areas of special-use airspace that allow more flexible operations of UAS and TBS for Arctic climate research.

Located in the Prudhoe Bay oilfield region on Alaska's North Slope, approximately 250 kilometers east-southeast of the town of Barrow, Oliktok Point provides exciting new opportunities to evaluate regional variability in the U.S. Arctic. These opportunities come not only from the added UAS capabilities but also from the fact that the DOE added an instrument observatory at Oliktok Point. This observatory expands upon DOE's extensive previous efforts in this environment, including nearly 20 years of observations at Barrow, a shorter deployment at Atqasuk (90 kilometers south of Barrow), and numerous field campaigns.

Opening the Arctic Skies

DOE's history at Oliktok Point started in 2004, when Sandia National Laboratories, through its involvement with the DOE Atmospheric Radiation Measurement (ARM) Climate Research Facility, worked with the FAA to develop an area of restricted airspace to support use of tethered balloon systems that observe the Arctic atmosphere. The area, designated R-2204, consists of a 4-nautical-mile-diameter cylinder centered on Oliktok Point and includes two height ranges, the first extending an elevation of 1500 feet and the second extending from 1500 to 7000 feet (see Figure 1, left; feet and nautical miles are the units the FAA uses when discussing airspace; 1 foot = 0.3 meter). That way, the entire air column does not need to be closed to outside air traffic when measurement activities are limited to low altitudes. Previously, this airspace hosted the ARM Mixed-Phase Arctic Clouds Experiment, which investigated cloud microphysics and radiative properties [*Verlinde et al.*, 2007], but saw minimal use afterward.

Over the past decade, usage of drones and tethered balloons for scientific study has become increasingly popular as technology has come down in price. For example, *Curry et al.* [2004] and *Inoue et al.* [2007] led initial efforts to fly over the North Slope of Alaska. However, the increased popularity of drones resulted in new restrictions on where and when these platforms can be operated, limiting their usefulness for advancing science. To meet the growing demand for airspace, in 2009 DOE again worked with the FAA to indefinitely extend the availability of R-2204 for DOE-supported research activities and increase the number of available days from 30 to 75 per year.

Spurred by the rapid decline in Arctic sea ice and the need to better understand the evolving Arctic atmosphere and its interactions with the surface, the DOE further worked with the FAA to develop a new block of airspace for researchers to use, extending approximately 700 nautical miles over the Beaufort Sea to the north of Oliktok Point (see Figure 1, right). This space, designated warning area W-220, is 40 nautical miles wide and divided into two altitude ranges (0–2000 feet and 2000–10,000 feet) and will provide critical access for scientists to the environment overlying the Arctic Ocean.

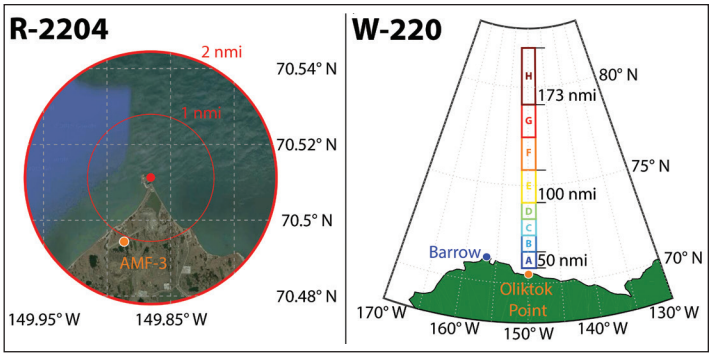

Fig. 1. Maps illustrating the extent of (left) restricted area R-2204 and (right) warning area W-220 in Alaska. (left) The circle centered on Oliktok Point spans 4 nautical miles (nmi); the airspace is split into two sections: low (up to 1500 feet above sea level) and high (from 1500 to 7000 feet above sea level). (right) Twenty nautical miles on either side of 149.86°W, bounded to the south by 70.78°N and to the north by 82°N. The warning area is divided into 16 sections of various lengths, including a low portion between 0 and 2000 feet above sea level and a high portion between 2000 and 10,000 feet above sea level.

Support on the Ground

To advance Arctic climate research, the DOE ARM Climate Research Facility has deployed a ground-based mobile research facility (AMF-3) to Oliktok Point, Alaska, until at least 2019. The facility is one of three that DOE operates and is equipped with a wide variety of instruments, including remote sensors for measuring cloud properties and energy transfer in the atmosphere (e.g., radars, laser-scanning lidar mapping, and radiometers), sensors for surface weather and airborne pollutants, and towers of instruments that measure the exchange of carbon and water vapor between the air and the ground.

When paired with this world-class surface observatory, unmanned aircraft and tethered balloons provide a unique asset. For example, the combined effort can gather detailed profiles of atmospheric properties from the surface to 7000 feet in elevation, as well as information on spatial heterogeneities across a given elevation.

All measurements, along with a variety of official and user-produced data products, are available for download through the ARM Data Archive (http://bit.ly/ARMarchive), providing easy access for the scientific community and general public. The Oliktok Point facility has also recently been integrated into the Arctic-wide International Arctic Systems for Observing the Atmosphere network [*Uttal et al.*, 2015], providing opportunities to further assess the spatial representativeness for the unique measurements obtained there.

Recent Flight Operations at Oliktok Point

Unmanned aircraft have flown several campaigns at Oliktok Point in recent years. In the summer of 2013, DOE worked with NASA, the National Oceanic and Atmospheric Administration, and the Office of Naval Research to carry out the Marginal Ice Zone Experiment to study the physics of the transition region between frozen sea and open water—a crucial element of climate models in the Arctic.

During this campaign, several different unmanned aircraft flew within and outside of R-2204, including flights into the surrounding international airspace. These aircraft collected atmospheric measurements and dropped small buoy systems into the sea to make in situ observations of the upper ocean along the ice water interface at the edge of the pack ice. During October 2014, DOE worked with the University of Colorado and Penn State University to carry out the Coordinated Observations of the Lower Arctic Atmosphere exercise to make detailed measurements of lower atmospheric thermodynamic variables during the time of sea ice formation offshore. This exercise featured both unmanned aircraft and tethered balloon flights within R-2204.

Flight activities were expanded in 2015, including the DOE-funded Evaluation of Routine Atmospheric Sounding Measurements using Unmanned Systems campaign, the U.S. Coast Guard Arctic Shield 2015 rescue training operations, additional tethered balloon flights, and the ARM Airborne Carbon Measurements campaign. The latter used both W-220 and R-2204 to complete low-altitude flights using a DOE-supported twin turboprop manned research plane [*Schmid et al.*, 2014]. ERASMUS flights targeted routine profiling of the lower Arctic atmosphere (up to 7000 feet) and measurements to understand the interactions between thermodynamic structure and cloud formation. ACME-V flights, although focused on observing atmospheric gas fluxes and transport, also featured a robust set of instrumentation to improve understanding of Arctic cloud and aerosol properties.

Moving Forward

To take advantage of the airspace at Oliktok Point, ARM is bolstering its drone and tethered balloon programs with a variety of new aircraft and instruments that will begin flying in 2016. Sandia National Laboratories, which manages the ARM measurement sites on Alaska's North Slope, already operates a variety of tethered balloon systems at Oliktok Point and has expanded their capabilities through a variety of miniaturized atmospheric instruments. For both UAS and TBS, this expanded effort will include sensors to measure clouds, aerosols, radiation, thermodynamics, and surface properties. ARM plans to operate these craft in both routine and focused campaign environments at Oliktok Point over the coming years.

Measurements from these platforms will be made available to the international research community through the ARM Data Archive, alongside measurements from other ARM facilities, including the Oliktok-deployed AMF-3 and the Barrow site. In addition, the airspace will be available for the scientific community to propose investigator-based UAS operations as part of ARM-sponsored field campaigns.

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AGU Signs Agreement with Council on Undergraduate Research

Seeing a critical need in Earth and space sciences for a steady pipeline of creative, knowledgeable, and diverse students, AGU has signed a memorandum of understanding (MOU) with the Council on Undergraduate Research (CUR). The new agreement aims to further the two organizations' shared goals of building and sustaining the global science talent pool. Founded in 1978, CUR supports and promotes high-quality undergraduate student-faculty collaborative research and scholarship.

The MOU focuses on developing and growing programs and activities to strengthen research opportunities in the Earth and space sciences at the undergraduate level. That includes expanding research experiences at 2-year colleges. The joint undertaking will also seek to enhance diversity in the undergraduate geoscience talent pool, as well as create opportunities for students who are low-income, first-generation college students or members of traditionally underrepresented groups in their sciences to present their work to the broader scientific community and beyond.

The new agreement aims to further the two organizations' shared goals of building and sustaining the global science talent pool.

"The initiative is in line with the strategic goals of CUR, not only to expand and retain undergraduate research opportunities, but to do so in a way that diversity is sought and achieved," said CUR executive officer Elizabeth Ambos. "I am thrilled about the opportunities that this relationship will represent to the members of the two organizations."

Presenting Research Virtually

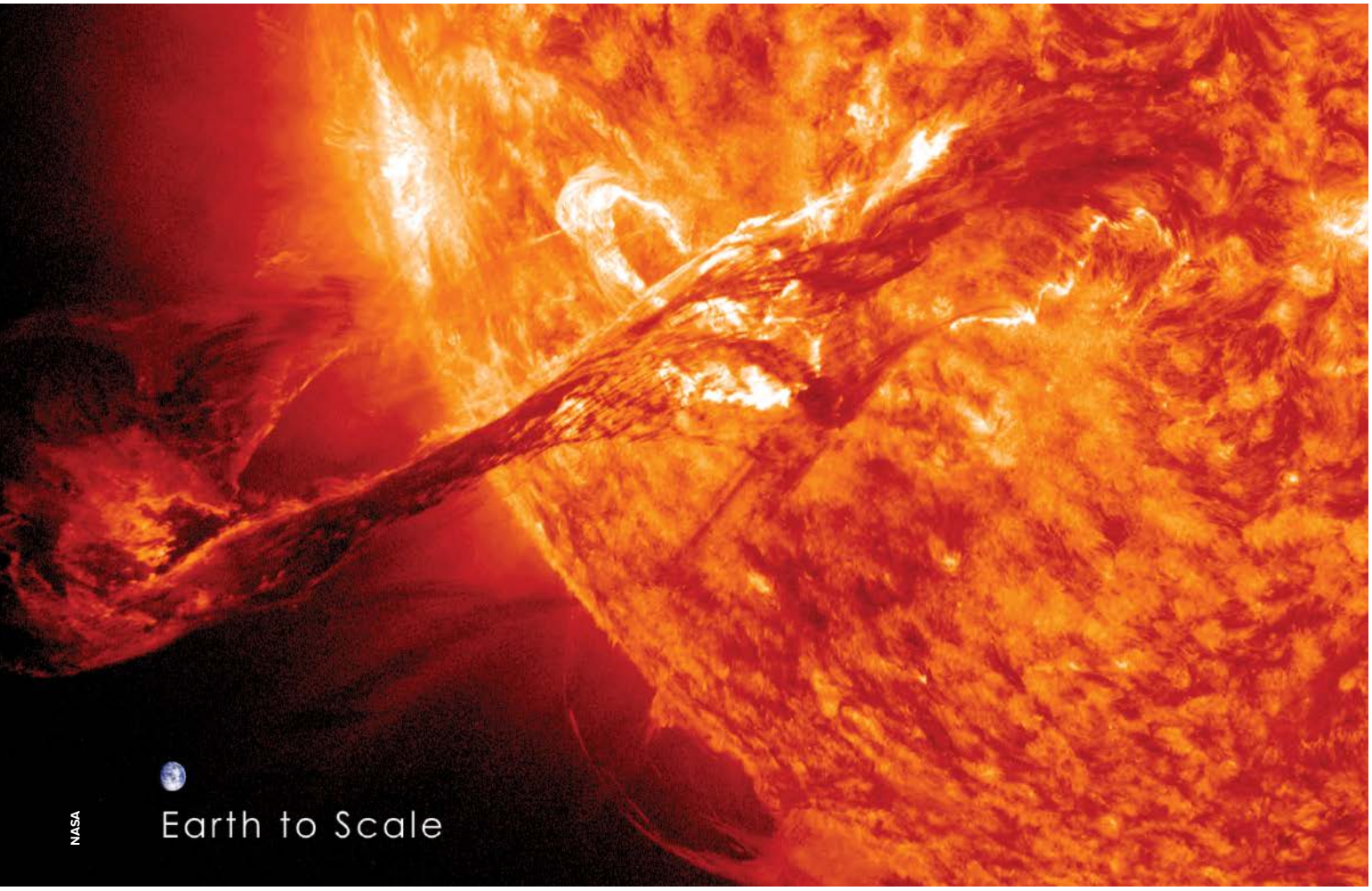
One of those opportunities is AGU's Virtual Poster Showcase (http://bit.ly/VPShowcase), a means for students to participate via a virtual electronic presence in presenting research. "The showcase will, no doubt, help broaden participation in research by providing many more students the opportunity to present the results of their inquiry without the added expense of travel," said CUR's geoscience division chair Lee Phillips. "As we all know, presentation of one's research has tremendous potential to be an incredibly transformative experience for aspiring scholars."

"From helping us to understand how and why natural hazards threaten our families and homes, to adaptation and mitigation strategies for the growing impacts of climate change, we know that Earth and space science research plays an important role in public health and well-being and the competitiveness of our economy," said AGU executive director/CEO Christine McEntee. "That's why it's so important that we develop and support a steady and diverse pipeline of creative and knowledgeable students who are well prepared to meet society's demands for scientific knowledge. It's also why AGU is so pleased to be able to partner with a respected and knowledgeable organization like CUR as we work to advance this important goal."

The MOU outlines the organizations' commitments to promoting undergraduate research opportunities, enhancing diversity in the geosciences, and supporting the geoscience talent pool. "Our combined efforts will help promote the offerings of each organization, which should broaden the pathways to careers in the geoscience community," said Phillips.

By **Joan Buhrman,** Strategic Communications Manager, AGU; email: jbuhrman@agu.org

New Solar Wind Model Could Improve Space Weather Forecasts



Solar material erupts from the Sun in a coronal mass ejection on 31 August 2012 (Earth added for scale). A new model of the solar wind emitted by the Sun could improve predictions of similar space weather events.

Severe space weather can harm satellites, spacecraft, and telecommunications systems on Earth's surface. Predicting serious events requires a solid understanding of the solar wind, a 1,609,344-kilometer-per-hour stream of charged particles constantly emitted by the Sun in all directions. However, solar wind dynamics are complex and pose many challenges for the scientists who study them.

A new approach by *Feng et al.* builds and improves on previous efforts to model the solar wind. Driven by real-world data, the new model predicts the behavior of the solar wind from the moment it leaves the Sun until its arrival at Earth.

The scientists based the new model on an older magnetohydrodynamics simulation that predicts the behavior of an electrically conducting fluid (the solar wind, in this case) in the presence of a magnetic field. The older model relies on daily maps of the magnetic field of the Sun's light-emitting layer, known as the photosphere.

To improve the older simulation, the scientists changed the way the daily magnetic field data are processed and used by the model. They also added a limit on the mass flux of the photosphere—the energy it emits over a given surface area.

The team tested the new model's predictions against solar wind observations from 1 July to 11 August 2008. The model accurately predicted features in the corona (the outer atmosphere of the Sun), including dark coronal holes and their corresponding streamer belts—the bright rays visible during a solar eclipse. The model also accurately predicted interplanetary solar wind behavior.

The new model was less accurate at predicting the total magnetic field strength during the observation period. It also failed to capture smaller coronal holes. Although improvements are needed, the model could help make better predictions of space weather, including extreme events like coronal mass ejections. (*Journal of Geophysical Research: Space Physics*, doi:10.1002/2015JA021911, 2015) **—Sarah Stanley, Freelance Writer**

Distant Rains Contributed to La Niña Ocean Warming Event

The 2010–2012 La Niña event caused extreme weather around the globe, from record snowfall in the northeast United States to severe drought in East Africa. It also resulted in unprecedented warming of ocean water off the coast of Western Australia in early 2011—an event termed the Ningaloo Niño—that killed fish and bleached coral in the region. *Feng et al.* have now shown that distant rainstorms intensified a major ocean current that contributed to the warming phenomenon.

From late 2010 to mid-2011, heavy precipitation lowered the salinity of surface ocean water in the maritime continent, a region that includes parts of Southeast Asia, Indonesia, and the Philippines. Using precipitation and upper ocean salinity data, together with modeling, the authors tracked the fate of this freshened water.

The researchers relied on free-drifting, battery-powered Argo floats, which repeatedly dive and resurface to relay temperature, salinity, and velocity data. They also used conductivity-temperature-depth measurements and mooring observations from a coastal monitoring station off Rottnest Island, located west of Perth. The station is part of Australia's Integrated Marine Observing System.

The authors found that the Indonesian Throughflow current carried the warm and unusually fresh water westward. The South Equatorial Current carried some of it farther into the interior Indian Ocean, while the Leeuwin Current diverted some of it southward along the west coast of Australia, contributing to the Ningaloo Niño.

Mat Vanderklift

A hawksbill turtle swims above the coral reef at Ningaloo, where the ecosystem is influenced by ocean currents that are determined by distant events.

Using a modeling product called BRAN3p5, developed by Australia's Commonwealth Scientific and Industrial Research Organisation, the scientists found that both temperature and salinity gradients generated a major increase in the volume of warm water transported by the Leeuwin Current. On its own, unusually low salinity was responsible for 30% of the increase in the current's volume transport over the course of the Ningaloo Niño.

Peering into past records, the researchers uncovered similarly anomalous water freshening off the coast of Western Australia during previous La Niña events. Climate and marine ecosystems in the region are profoundly affected by heat transport of the Indonesian Throughflow and the Leeuwin Current, which makes it increasingly important for scientists to understand how La Niña affects their flow. (*Geophysical Research Letters*, doi:10.1002/2015GL065848, 2015) **—Sarah Stanley, Freelance Writer**

Satellites Reveal Dynamics of Suspended Mineral Particles

A new study has demonstrated the feasibility of using remotely sensed data to study the optical properties of mineral particles in offshore settings. The image shown was generated by the authors from NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) Aqua data collected from the Irish Sea.

Scientists often use optical measurements of mineral particles suspended in the water column to gather information about aquatic ecosystems. These data have applications in broader society such as assessing ecosystem health, monitoring environmental impacts, and validating numerical ecosystem models. In offshore waters, however, it's difficult to collect such optical information, especially during winter, when the concentrations may be much higher.

To evaluate the potential for using satellites to measure the particles' optical properties, *Mitchell et al.* developed a sequence of algorithms and applied it to 8 years of Moderate Resolution Imaging Spectroradiometer (MODIS) ocean color data. Using these algorithms, the team was able to discern complex patterns across time and space in the mineral particles suspended in the Irish Sea, the body of water nestled between Ireland and Great Britain.

The results show that during the autumn and winter, when the Irish Sea is stirred by a combination of wind and tides, the concentrations of suspended mineral particles are relatively high and peak in the center of the region. By late spring, however, the northern and southern portions of the sea become thermally stratified, and the data indicate a decrease in the concentrations of mineral particles in the surface layer that coincides with the onset of the spring phytoplankton bloom.

Although the authors advise that caution is required in extrapolating the values of the optical properties obtained for the Irish Sea to other regions and that more work must be done to reduce uncertainties and separate out the effects of errors in the MODIS data, this case study suggests that it is now feasible to use remote sensing data to study the optical properties of suspended mineral particles in offshore waters, even in cloudy areas. (*Journal of Geophysical Research: Oceans*, doi:10.1002/2015JC011056, 2016) **—Terri Cook, Freelance Writer**

Tracking the Fate of Antarctica's Ice

Thick shelves of floating ice line much of Antarctica's coast, slowing the loss of the glaciers that feed them and stabilizing the continent's huge interior ice sheet. Scientists need to know the shelves' thickness to monitor ice loss in the region, which can affect global sea level.

Now, using the European Space Agency's CryoSat-2 satellite, *Chuter and Bamber* have made the most complete and accurate measurements yet of Antarctic ice shelf thickness. Their measurements include 92.3% of the total surface area of the continent's ice shelves—more than is covered by any other data set.

The researchers attribute the improved coverage to CryoSat-2's unique orbit and instruments. CryoSat-2 uses radar altimetry—which relies on pulses of radar waves that bounce off the icy surface—to measure ice shelf elevation. Unlike previously used radar altimeters, CryoSat-2 has no trouble measuring sudden breaks in the slope at the inland limit of the ice shelves—an important region to monitor—called the grounding zone. The researchers collected elevation data from 2011 through 2014 and calculated ice shelf thickness based on the local sea level.

Jonathan Bamber

A section of the Filchner Ronne Ice Shelf in West Antarctica, which extends for some 800 kilometers in length and buttresses several major glaciers in both West and East Antarctica.

On average, the new elevation measurements were 4 times more accurate than the best previous continent-wide measurements (when compared to data from NASA's Ice, Clouds and Land Elevation Satellite (ICESat) mission). The biggest improvements were within 10 kilometers of the grounding line, where the base of a floating ice shelf meets Antarctic land. Thickness measurements in this zone are particularly important for ice loss calculations.

The new thickness measurements rely on the assumption that ice shelves float freely in hydrostatic equilibrium with seawater, which means the gravity acting on a shelf is balanced by the upward pressure of the water beneath it (Archimedes's principle). This assumption may cause errors in the more complex grounding zone, but it is a good approximation for continent-wide ice shelf modeling.

To validate their findings, the scientists compared their data to several ice-penetrating radar data sets, which measure the ice thickness directly. These included the extensively studied Amery Ice Shelf. This shelf is located in East Antarctica and drains several major glaciers. The mean thickness difference between the new satellite-derived ice thickness and the ice-penetrating radar data was 3.3% across the shelf and 4.7% within 10 kilometers of the grounding zone.

The new ice shelf thickness measurements will be made freely available and can be incorporated into the next version of the widely used, continent-wide BEDMAP data set. Beyond ice loss monitoring, the new data will aid efforts to map areas of marine ice and model ocean circulation below the ice shelves. (*Geophysical Research Letters*, doi:10.1002/2015GL066515, 2015) **—Sarah Stanley, Freelance Writer**

Ocean Waves Vibrating the Ross Ice Shelf

Peter Bromirski

The solar panel of a seismic station buried in the ice, 2 kilometers from the front of the Ross Ice Shelf, Antarctica. At the time the picture was taken, conditions on site were challenging—the air temperature was about −20°F.

Warming global temperatures have concerned scientists for several years now, but the local impacts of a changing climate are still being revealed. With their rapidly increasing melt rates, the Earth's poles are a canary in the coal mine. Ice shelves, like Antarctica's Ross Ice Shelf, act as icy buttresses that hold back glaciers draining toward the ocean from the interior of the continent; without these frosty restraints, glaciers flow directly into the ocean and speed sea level rise. Understanding how ice shelves respond to climate change and its effects on ocean–ice shelf interactions is critical for calculating potential changes in sea level that would impact economies and ecosystems around the world.

To assess the behavior of the Ross Ice Shelf, *Bromirski et al.* measured vibrations produced by two types of gravity waves—ocean swell generated by wind from storms at sea and infragravity waves generated when swell interacts with coastlines.

Broadband seismic stations on the Ross Ice Shelf captured signals produced when swell and infragravity waves from the North Pacific reached Antarctica, and the authors studied how the ice shelf responds to the wave impacts. Vibrations caused by impacts of waves from both the Southern Ocean and the North Pacific were detectable 100 kilometers from the shelf front. The measurements also revealed that shelf thickness, storm activity, and the extent of sea ice produced variations in amplitude, timing, and spatial distribution of the vibrations. The effect of these vibrations indicates that waves consistently cause the shelf to extend existing cracks and crevasses and drive iceberg calving.

The role of ocean waves in weakening the ice shelf is central to a better scientific understanding of the health of polar ice shelves. The study shows that the relationship between ocean gravity wave–induced vibrations and the structural integrity of ice shelves is a vital measure of how the poles will respond to future climate changes. Ultimately, the shifting dynamics of polar ice will have acute consequences for lives and livelihoods around the world. (*Geophysical Research Letters*, doi:10.1002/2015GL065284, 2015) **—Lily Strelich, Freelance Writer**

Can We Predict How Volcanic Ash Disperses After an Eruption?

G. Famiani

The 4 December 2015 paroxysm plume from Mount Etna's Voragine crater, as seen from Cesarò, Messina, at 9:27 Greenwich Mean Time.

On 24 November 2006, Mount Etna—located in Sicily, Italy—erupted, releasing a thick plume of volcanic ash. The eruption shut down Fontanarossa Airport, Sicily's second largest, located 48 kilometers away. Similar plumes occurred again in December 2015.

Volcanic ash affects not only air transit but also public health and agriculture in nearby communities. How particles scatter after an eruption is incredibly complex and chaotic because of the different behavior of particles of different size and the uncertain distribution of particles at the source. Some particles can linger in the air for just a few minutes, whereas others can remain airborne for years, traveling thousands of miles around the world. Here *Pardini et al.* investigate how particles from a volcanic plume disperse and what factors govern the uncertainties associated with dispersal.

The researchers performed their calculations on the basis of the conditions of the 2006 eruption of Mount Etna. Using a Lagrangian particle dispersal model, which computes the trajectories of a large numbers of volcanic particles on the basis of their physical properties, the researchers investigated how uncertainty in the initial size distribution of particles and their sphericity—a measure of how round an object is—affected how each particle scattered following a volcanic eruption. This model also accounted for realistic conditions such as wind.

The scientists found that the uncertainty in the distribution of particles greatly reduces with distance from the source because of the effective segregation imposed by the atmospheric dispersal process. Moreover, rounder pieces of volcanic ash experienced less drag in the air, so they slipped out of the atmosphere sooner and didn't travel as far. Conversely, particles that weren't as spherical experienced more drag and remained in the atmosphere longer. As a consequence, sphericity mostly controls the grain size distribution at a given distance from the source. The authors also found much more variation in the size of particles that stayed aloft compared with those on the ground.

Although the study was based on a weak plume event during the Mount Etna eruption in November 2006, the authors say that the method used in this study can also be applied to investigate particle scattering from larger plumes.

This study determined variables that control particle scattering, which, according to the authors, warrant more analysis so that models that examine similar phenomena can be further refined. (*Journal of Geophysical Research: Solid Earth*, doi:10.1002/2015JB012536, 2016)

—Wudan Yan, Freelance Writer

Atmospheric Sciences

Postdoctoral Fellows in Atmospheric Sciences and Oceanography (2) at the Department of Meteorology. Closing date: 10 April 2016.

The Department of Meteorology at Stockholm University (MISU) invites candidates to propose a 2-year project in Atmospheric sciences and Oceanography, to be conducted at MISU.

At MISU we conduct research and education in an international environment within four main areas: Atmospheric physics, Dynamic meteorology, Physical oceanography and Chemical meteorology. In all these areas there is a strong focus on climate and on processes important for the climate and its development. The department employs some 70 individuals, of which about 30 are scientists, 25 PhD students and 15 in the administration and technical support. The department is a part of the Bolin Centre for Climate Research, and together with the three other departments we cover research of most of the important aspects of the climate system.

Project description

The positions are open in a wide field of atmospheric and oceanographic research. We expect the candidates to suggest a project developed in discussions with one of the scientists at the department (see list of contacts at www.misu.su.se/about-us/vacancies).

Qualification requirements

Postdoctoral positions are appointed primarily for purposes of research. Applicants must hold a Swedish doctoral degree or an equivalent degree from another country. The candidate must have obtained a PhD degree in meteorology, atmospheric sciences or other relevant field.

Assessment criteria

The applicant should have excellent English language skills, both oral and written communication. In addition to scientific merits, the quality of the project plan will be important when assessing the applicants.

Interviews for the positions are likely to take place during May 13–20.

Terms of employment

The positions involves full-time employment for a maximum of two years. The preferred starting date is 1st of September 2016, but a later date is possible.

Stockholm University strives to be a workplace free from discrimination and with equal opportunities for all.

Contact

For further information contact the Head of the Department, Prof. Jonas Nycander, telephone: +46 8 16 43 36, prefekt@misu.su.se.

Union representatives

Anqi Lindblom-Ahlm (Saco-S) and Lisbeth Häggberg (Fackförbundet ST), telephone: +46 8 16 20 00 (operator), and Gunnar Stenberg (SEKO), telephone: +46 70 316 43 41.

Application

Apply for the position at Stockholm University's recruitment system by clicking the "Apply" button. It is the responsibility of the applicant to ensure that the application is complete in accordance with the instructions in the job advertisement, and that it is submitted before the deadline.

Please include the following information with your application

- Your contact details and personal data
- Your highest degree
- Your language skills
- Contact details for 2-3 references

and, in addition, please include the following documents

- Cover letter
- CV - degrees and other completed courses, work experience and a list of publications
- Brief project plan (one or two pages)
- Copy of PhD diploma
- Publications in support of your application (no more than 3 files).

The instructions for applicants are available at: Instructions - Applicants.

You are welcome to apply!

http://www.su.se/english/about/vacancies/vacancies-new-list?rmpage=job&rmjob=1146&rmlang=UK

Hydrology

Post-doctoral Fellowship in National Scale Modeling of River Corridors

New Mexico Tech's Hydrology Program (www.ees.nmt.edu) is seeking applications for a post-doctoral fellow to join the USGS Powel Center's "River Corridor Group" (https://goo.gl/JjnKgB). This position offers a unique opportunity for collaborative synthesis with recognized academic and government leaders in Earth Sciences, providing fundamental scientific advancement to societally relevant challenges. The appointment will support a national-scale synthesis project to improve the characterization of river hydrogeomorpohology and its cumulative influence on water quality. The project integrates data mining, assimilation and synthesis of large physical and biogeochemical datasets with new physics-based models for transport in large river networks. Research goals include assembling and assimilating hydrogeomorphic data into a new river corridor transport model to assess cumulative effects, and forecast outcomes for changing water quality at the scale of the nation. Applicants should have a demonstrated ability to independently develop research questions and answer them by consolidating large data sets into mathematical models. In addition, applicants are expected to work collaboratively with the Powell Center group, leading research activities that generate the submission of two or more peer-reviewed publications each year. The successful candidate will be hosted at New Mexico Tech's Hydrology Program under the supervision of Dr. Jesus Gomez-Velez with additional supervision by the other project PIs Dr. Jud Harvey (USGS), Dr. Elizabeth Boyer (Penn State), and Dr. Durelle Scott (Virginia Tech). The appointment is for up to two years, and computing facilities and travel are supported. Interested applicants should email a CV, one relevant publication, a one-page statement of past and present research goals, and the names and addresses of three references to Dr. Jesus D. Gomez-Velez (jdgomez@nmt.edu). The preferred due date for applications is April 30, 2016. However, applications will be reviewed as they are received until the position is filled.

Solid Earth Geophysics

ASSISTANT RESEARCH SCIENTIST - IODP Expedition Project Manager/Staff Scientist

The International Ocean Discovery Program (IODP) at Texas A&M University invites applications for an Assistant Research Scientist (Expedition Project Manager/Staff Scientist) in our Science Operations section. Preference will be given to applicants with exper-

POSTDOCTORAL RESEARCH AND VISITING RESEARCH SCIENTISTS
ATMOSPHERIC AND OCEANIC SCIENCES
PRINCETON UNIVERSITY/GFDL

In collaboration with NOAA's Geophysical Fluid Dynamics Laboratory (GFDL), the Atmospheric and Oceanic Sciences Program at Princeton University solicits applications to its Postdoctoral and Visiting Research Scientist Program.

The AOS Program and GFDL offer a stimulating environment with significant computational and intellectual resources in which to conduct collaborative or independent research. We primarily seek applications from recent Ph.D.s for postdoctoral positions but will accept applications from more experienced researchers. Applications from independent researchers and more senior scientists who may need partial support for sabbatical or short visits may also be considered. Postdoctoral or more senior appointments are initially for one year with the possibility of renewal for a second year based on satisfactory performance and continued funding. A competitive salary is offered commensurate with experience and qualifications.

We seek applications in all areas of the climate sciences. This includes research in basic processes in atmospheric and oceanic dynamics; climate dynamics, variability and prediction; atmospheric physics and chemistry; cloud dynamics and convection; boundary layer processes; land-sea-ice dynamics; continental hydrology and land processes; physical oceanography; ocean-atmosphere interaction; climate diagnostics and analysis. Applicants must have a Ph.D. in a relevant discipline.

Further information about the Program may be obtained from: http://www.princeton.edu/aos/. Applicants are strongly encouraged to contact potential hosts at GFDL and Princeton University prior to application to discuss areas of possible research.

Complete applications, including a CV, copies of recent publications, at least 3 letters of recommendation, and a titled research proposal should be submitted by April 30, 2016 for full consideration. Applicants should apply online to http://jobs.princeton.edu, Requisition #1600132. These positions are subject to the University's background check policy. Princeton University is an equal opportunity employer and all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, national origin, disability status, protected veteran status, or any other characteristic protected by law.

tise in petrology, inorganic (fluid) geochemistry, downhole logging, petrophysics, and sedimentology. However, applicants in any field of geoscience pertinent to IODP will be considered.

A Ph.D. in geosciences or related field, and demonstrated on-going research experience is required. Applicants must have a demonstrated fluency in written and spoken English. Experience as a seagoing scientist, especially in scientific ocean drilling, is preferred.

This position will serve as the Expedition Project Manager to coordinate all aspects of precruise expedition planning, sea-going implementation, and postcruise activities. These duties include sailing as the IODP scientific representative on a two-month IODP expedition approximately once every 1 to 2 years.

Individual scientific research, as well as collaboration with colleagues at Texas A&M University in fulfilling its educational mission, is required.

This position will also provide scientific advice on laboratory developments in their area of specialization including scientific implementation of downhole logging on the JOIDES Resolution. Applicants must be able to cooperate and work harmoniously with others, have the ability to be an effective team leader, and foster collaboration among diverse scientific participants. Passing a new employee medical exam and annual seagoing medical exams are a requirement of the position.

Salary will be commensurate with qualifications and experience of the applicant. This is a regular full time position, contingent upon continuing availability of funds for IODP. We will begin reviewing applications on 16 May 2016, but will continue to accept applications until candidates are selected for interviews. Applicants may access the TAMU application at https://jobpath.tamu.edu and apply online with reference to Posting Number O00086FY16, attach a curriculum vita, list of published papers, statement of research interests, and names and addresses of three references. Quick Link -

http://jobpath.tamu.edu/postings/93404

Interdisciplinary/Other

National Science Foundation National Search, NSF Assistant Director for Geosciences

The National Science Foundation is initiating a national search for the National Science Foundation's Assistant Director for Geosciences (GEO) and seek your assistance in the identification of candidates. Dr. Roger Wakimoto has served in this position, with distinction, since February 2013.

The Assistant Director, GEO, leads a directorate comprised of four divisions: Atmospheric and Geospace Sciences (AGS), Earth Sciences (EAR), Ocean Sciences (OCE), and Polar Programs (PLR). A summary of the directorate's activities, the responsibilities of the position, and the criteria used in the search are available at http://www.nsf.gov/od/searches/geo-160307/nsf_ad_geo_search_letter.jsp.

We are very pleased to announce that Dr. Ralph Cicerone, President of the National Academy of Sciences, will head the search committee. We seek your help in identifying candidates with the following qualifications: outstanding leadership; a deep sense of scholarship; a grasp of the issues facing the geosciences in the areas of research and education; experience developing and overseeing complex scientific facilities; and the ability to serve effectively as a key member of the NSF management team. Recommendations of individuals from any sector – academic, industry, or government – are welcome. The National Science Founda-

UNIVERSITY OF CAMBRIDGE

www.jobs.cam.ac.uk

BP Foundation McKenzie Professorship of Earth Sciences

Department of Earth Sciences

The Board of Electors to the BP Foundation McKenzie Professorship Earth Sciences invite applications for this Professorship from persons whose work is connected with quantitative physical Earth Sciences to take up an appointment in October 2016 or as soon as possible thereafter.

Candidates will have an outstanding research record of international stature in quantitative physical Earth Sciences, especially in the broad areas of geophysics, geodynamics or tectonics and the vision, leadership, experience and enthusiasm to build on current strengths in maintaining and developing a leading research presence. They will hold a PhD or equivalent postgraduate qualification.

Standard professorial duties include teaching and research, examining, supervision and administration. The Professor will be based at the Bullard Laboratories in north-west Cambridge. A competitive salary will be offered.

To apply online for this vacancy and to view further information about the role, please visit: http://www.jobs.cam.ac.uk/job/9517.

Further information is available at: www.admin.cam.ac.uk/offices/academic/secretary/professorships/ or contact the Academic Secretary, University Offices, The Old Schools, Cambridge, CB2 1TT, (email: ibise@admin.cam.ac.uk).

Applications, consisting of a letter of application, a statement of current and future research plans, a curriculum vitae and a publications list, along with details of three referees should be made online no later than 2 May 2016.

Informal enquiries may directed to Professor James Jackson, Head of the Department of Earth Sciences, Cambridge, telephone +44 (0)1223 333481 or email jaj2@cam.ac.uk

Please quote reference LB08361 on your application and in any correspondence about this vacancy.

The University values diversity and is committed to equality of opportunity.

The University has a responsibility to ensure that all employees are eligible to live and work in the UK.

tion is an equal opportunity employer committed to employing a highly qualified staff that reflects the diversity of our nation.

Please send your recommendations, including any supporting information that you can provide, to the AD/GEO Search Committee via e mail (geosrch@nsf.gov) or at the following address: National Science Foundation, Office of the Director, Suite 1205, 4201 Wilson Boulevard, Arlington, VA 22230. We would appreciate receiving your recommendations by May 20, 2016.

Your assistance in this very important task is appreciated.

Student Opportunities

Northwestern University seeks postdoctoral scholar in Water Data Science to coordinate activity between the Center for Water Research and partners Argonne National Laboratory and The Nature Conservancy on synergies in urban water, food, energy, and ecosystems. Objectives are to integrate theory, data and models to enable safe, efficient and sustainable management of urban land, water, and ecosystems. Applicants should submit CV, research statement, and three references to water@northwestern.edu.

U.S. Graduate Student Scholarships for the 2016 Urbino Summer School in Paleoclimatology (USSP)

The 13th Urbino Summer School in Paleoclimatology (13–29 July; http://www.urbinossp.it/) will provide graduate students with an intensive program on reconstructing the history and dynamics of paleoclimate through an integrated series of lectures, investigations, case studies, and field analyses. To promote U.S. graduate student participation in this international experience, the National Science Foundation is funding ten scholarships to cover U.S. carrier airfare, stipend, and course expenses (including lodging). Interested students in U.S. graduate programs should email a pdf file comprised of a one-page CV and one-page statement on how the USSP would benefit their professional development as a researcher and educator to nsfusspscholarship@gmail.com. In addition, students should request their primary adviser to email a recommendation letter directly to the above email address. Members of historically underrepresented groups are encouraged to apply. Deadline for receipt of application materials, including recommendation letters, is 20 April 2015.

Ocean Prediction Postdoctoral Positions Naval Research Laboratory, Stennis Space Center, MS

The Naval Research Laboratory is seeking postdoctoral researchers to push forward the frontiers of ocean forecasting, covering a wide scope of physics including surface waves, thermohaline circulation, nearshore circulation, and ocean/atmosphere coupling from global to nearshore scales. This challenging work includes processing and analysis of satellite and in water observations, construction of numerical model systems on high performance computing and assimilation for predicting the ocean environment. For a quick overview of some of the research projects within the NRL oceanography division at Stennis Space Center, visit the web site: **http://www7320.nrlssc.navy.mil/projects.php**

Applicants must be a US citizen or Permanent Resident at time of application. NRL is an Equal Opportunity Employer. Applications will be accepted until positions are filled. Please e-mail a resume and description of research interests:

Gregg Jacobs: jacobs@nrlssc.navy.mil

Postcards from the Field

Greetings!

Cambridge Earth System Science grad students have been exploring the geology, ecology, and archaeology of western Newfoundland on their latest visit to the field. Cambrian thrombolites sit like giant macarons along the shore. These fossil algal mats are some of the earliest vestiges of life on Earth.

Wish you were here!
Simon Redfern,
Department of Earth Sciences,
University of Cambridge

View more postcards at
http://americangeophysicalunion.tumblr.com/tagged/postcards-from-the-field.

AGU FALL MEETING

San Francisco | 12–16 December 2016

Have an Idea or Topic to Present at the Fall Meeting?

Submit a Session Proposal

Deadline:
20 April, 11:59 P.M. EDT

You must be current in your 2016 membership dues in order to propose a session.

fallmeeting.agu.org